its lowest density in the equatorial region. According to the hypothesis, therefore, of the general vertical oceanic circulation (which is true, but not as depending upon temperature alone), and to the superadded hypothesis that the excess of precipitation in the southern hemisphere causes the thrust of sub-marine cold water into the Atlantic and North Pacific, we should find, what we do *not* find, on account of that very excess of precipitation in the southern hemisphere—the surface waters receding everywhere south of the equator, from the equator towards the southeast, to be of very low specific gravity; which contradicts the statement premised with reference to the specific gravity of the surface waters on each side of the equator, which statement truly represents the facts of the case.

As long as the earth under its present physical conditions shall endure, the movements of the ocean must remain as they now exist, passing through phases of maxima and minima of volume and velocity and oscillation in direction, dependent upon their astronomical and terrestrial relations. The present oceanic forces are, in fact, huge hydraulic engines, worked by nature from the north pole and the south, nor less from the equator and the revolution of the earth. The Gulf Stream, with the analogous Japan Current, is merely one of the two greatest products of that machinery, the flow from its colossal pump, in the direction of its discharging tube and the general circulation of the ocean, partially actuated by the earth's rotation and by the sun-generated winds, being ceaselessly engaged in life-giving and life-aiding agency on the globe.

R. MEADE BACHE.

PHYSIOLOGY IN 1894.

No striking discovery in physiological science was made in the year 1894, and yet a large amount of substantial work has been accomplished both at home and abroad. Only a few of the more remarkable researches can be here referred to. It has long been known that the swimming or air bladder of sea fishes contains a much larger percentage of oxygen than exists in atmospheric air. The amount may rise as high 85 per cent. The mode of storage of this large amount of oxygen has always been an interesting question with physiologists, taken in connection with the very small amount of oxygen in sea water. Light has been shed on this problem by the ingenious researches of Professor Bohr, of Copenhagen, who has succeeded in tapping the air bladders of codfish and of drawing off the gas by means of a trocar and an air-tight syringe. He found that the gas contained 52 per cent. of oxygen. In a few hours the bladder was refilled apparently by a process of secretion of gas from the blood in the capillaries on the wall of the bladder, and in one experiment the gas thus secreted contained no less than 80 per cent. of oxygen. Puncture of the air bladder always caused increased secretion of oxygen, but after section of the nerves supplying the organ the evacuated bladder was not refilled with gas. Thus the formation of the gas in the air bladder, which corresponds to the lung of air-breathing animals, is a true secretion of a highly oxygenated gaseous mixture, and the secretion is evidently to some extent under nervous influences. These observations are very interesting when taken in connection with the hydrostatic functions of the swimming bladder. When a deep sea fish descends from near the surface the air bladder is compressed and the body is reduced in size, but to bring the body into equilibrium with the water the fish secretes gas in the air bladder so as to distend it and bring back the body to the original size. This newly-formed gas consists chiefly of oxygen. These experiments by Professor Bohr tend generally to support the theory that the

gaseous exchanges occurring in the lungs of air-breathing animals are not due to purely physical causes, such as different partial pressures of the gases, but to a true process of secretion and excretion.

Very considerable progress has been made in unravelling the intricate mechanism of the brain and spinal cord, and this has been accomplished mainly by the application of the Wallerian method of studying the degenerations that follow section of various strands of nerve fibres or destruction of gray matter. Mott has given experiments that support Munk's original conclusion that the motor area on the cortex of the cerebral hemispheres is also connected with sensations of touch and pressure, and is not solely for the emission of motor impulses, or, in other words, that the mechanisms for sensation and touch and for motor impulses are closely related in the brain. Bayliss, Bradford, Boyce, Sherrington, Langley and Anderson in this country have also investigated the convexions of the various spinal nerves with the great plexuses or networks from which issue the main nerves of the limbs, and thus physiologists are slowly accumulating knowledge that will by-and-by be of great value to the physician. It will be possible to correlate sensations in various areas in the skin and various muscular movements with certain nerve roots and with certain portions of the spinal cord. In other words, a new physiological anatomy will be established by experiment and facts will be discovered that could never be laid bare by the scalpel. The most notable advance, however, in nervous physiology has been made by Gustav Mann, of Edinburgh, who, following the lead of an American observer, has demonstrated material changes following the stimulation of nerve cells in the sympathetic ganglia, in the cord, and even in the brain itself. Under stimulation the cells appear to swell and to become clearer owing to a peculiar matter termed chromatin being used up. In this way even long continued stimulation of the retina by light has been found to cause changes, visible to the microscope and depicted by photography, in the nerve cells of the part of the brain which is the seat of the consciousness of vision.

Numerous researches have been made on the functions of the liver, kidney, pancreas and spleen, all going to show that these organs are not related only to one or even two individual functions, but that each organ is the seat of complex metabolisms, or changes of which the obvious secretion is only the outward expression. Thus, the liver not merely secretes bile and forms glycogen, but it also has important antitoxic powers by which poisonous matters, formed possibly in the intestines and carried thence to the liver, have their effects counteracted. The organ is also concerned in the decomposition of proteids and even in the transformation of fats. In like manner the kidneys and the pancreas have intestinal functions, the nature of which is still obscure to physiologists. Lastly, the selective actions of epithelial cells are receiving greater attention, and it is found that these play an important part in many vital phenomena. By the activities of these cells physical operations, such as the passage of certain substances through membranes, are so modified as to make it impossible, in the present state of science, to regard them as purely physical. A molecular physiology of the future may demonstrate that they are truly physical, but at present the vitality of the tissues involved is an unexplained factor in the process.

In the field of physiological acoustics the phonograph promises to be an instrument valuable in research. Soon after its invention the tinfoil phonograph was used successfully by the late Professor Fleeming Jenkin and Professor Ewing (now of Cambridge) in the investigation of vowel sounds,

but the instrument was little known to physiologists. Since 1890, however, it has in its improved form, with a wax cylinder, engaged the attention of Professor Hermann, of Königsberg, and more recently of Dr. Boeke, of Alkmaar, and of Professor M'Kendrick, of Glasgow. By an ingenious method of photographically recording the vibrations of the marker that runs over the impressions produced by sounds on the wax cylinder of the phonograph, and which, by acting on a thin glass plate, reproduces the sounds, Hermann has obtained the curves corresponding to the tones of the vowels, and he has shown that the vowels are true musical tones, each having its own proper pitch, and not, as Von Helmholtz supposed, the pitch of a harmonic tone corresponding to the shape of the oral cavity when the vowel sound is uttered. When one considers that the phonograph can faithfully reproduce human speech, the sounds of a musical instrument, of a quartette or chorus of human voices, or the sounds of an orchestra, and that all these sounds and tones are imprinted on the wax cylinder of the phonograph in the form of a more or less complicated wave, it is manifestly of great importance to determine the wave form for any particular sound. If this could be done, not only would it be of great scientific interest to submit the curve to harmonic analysis (as was done by Jenkin and Ewing), and thus determine the component waves, but it might be possible to cut the curves on the margin of a wheel, or other appropriate device, and thus construct a speaking or singing machine. Speech and song and orchestral effects might be multiplied mechanically. The grooves on the wax cylinder vary in depth from the 1–1000th to the 1–2000th of an inch, and, thus, as the curve is in the bottom of the groove, it is a difficult matter to trace its form. Boeke has measured the transverse diameters of the grooves at different points, and from these measurements he has calculated the depths, and thus he has endeavoured, as it were, to construct the curve. M'Kendrick has taken direct photographs of the marks on the wax cylinder, and has thus been able to demonstrate vibrations (or 'dabs' on the wax cylinder traveling with great velocity) made at the rate of 1,500 to 1,800 per second. He has also shown that there is a definite form of these markings for pure tones, for the simpler chords, and for very complex tones, such as those of the organ, piano, or a quartette or chorus of human voices. By adapting large resonators to the phonograph, M'Kendrick has also made it possible to so increase the volume of tone as to make it audible even in a hall of considerable size. Edison and others have frequently used large resonators, but M'Kendrick has gone further in this direction. Recognizing, however, that resonance cannot increase the volume of tone beyond a certain limit, he has made use, with much success, of Mr. Alfred Graham's ingenious loud-speaking telephone, along with a transmitter of variable resistance, as supplied by Messrs. Muirhead and Co., of Westminster. In this way the tones of the phonograph are much amplified in volume and improved in quality. To physiologists the interest of these researches lies in the mode of action of the vibrating plate of the phonograph. This acts like the drumhead of the ear. Consequently the better the modes of movement of such a plate are understood the better can we explain the mechanism of the drumhead of the ear—a drumhead, however, infinitely more sensitive than the phonograph plate.—*London Times.*

CURRENT NOTES ON PHYSIOGRAPHY (XIII.).

THE CATOCTIN BELT OF MARYLAND AND VIRGINIA.

THE Blue ridge, dwindling from the Carolina highlands, extends a few miles north of the Potomac at Harper's Ferry, there